

A scanning electron micrograph (SEM) showing the intricate structure of male moth sex scales. The scales are arranged in a series of overlapping, wavy rows, creating a textured, almost woven appearance. The individual scales are small and elongated, with a distinct border. The overall structure is conical, tapering towards the bottom.

Male Sex Scales of Moths

Richard L. Brown, Joaquin Baixeras, Sangmi Lee

Historical Work

- Baillif (1825) - first record of microscopic male-limited structures (in *Pieris rapae*).

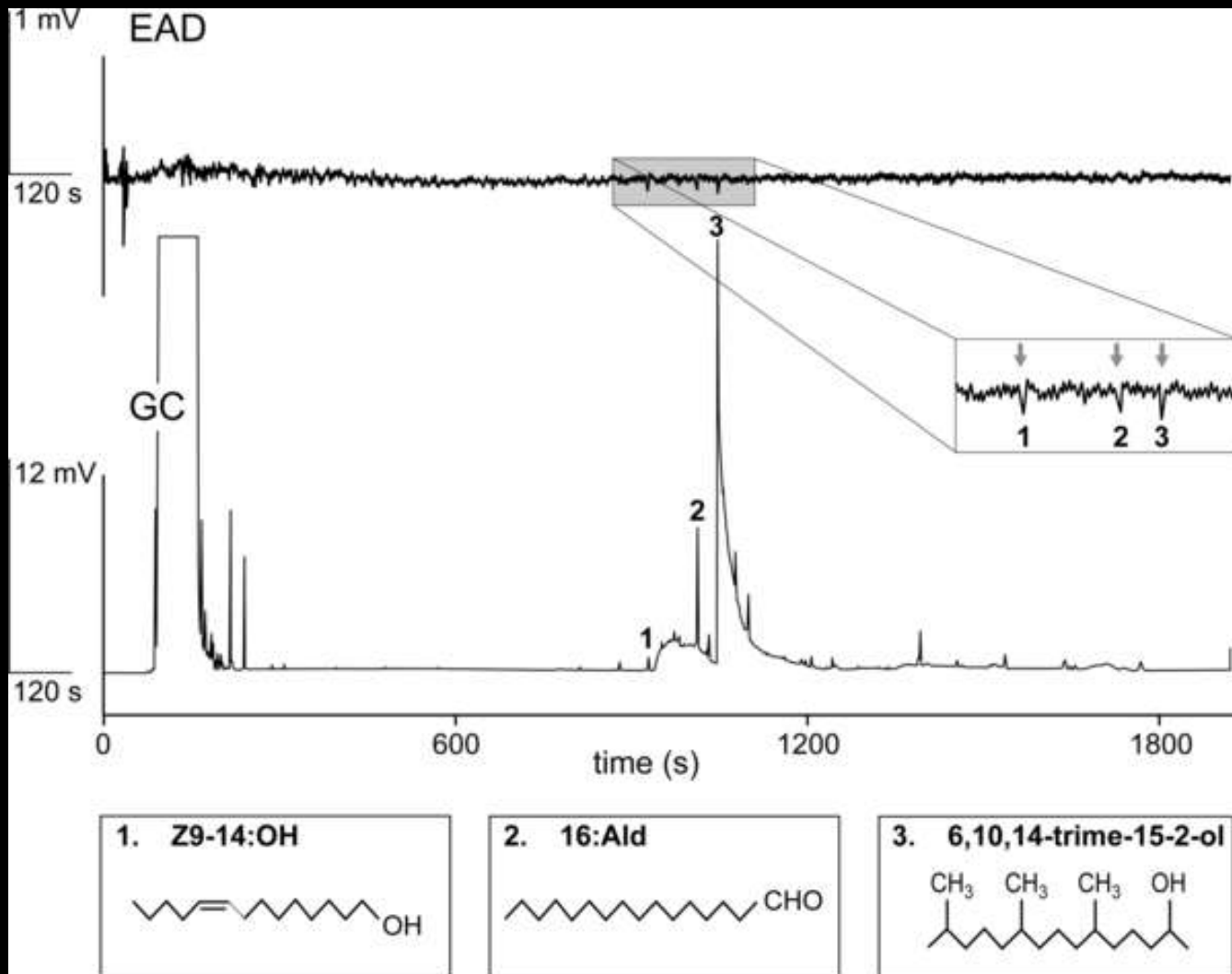
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- Fritz Muller (1877 and subsequent works) -
“Odoriferous organs.” “....diffuse scents, which are undoubtedly agreeable to the females and arouse their sexual desires.”

Male Pheromone of *Bicyclus anynana*



(Z)-9-tetradecenol

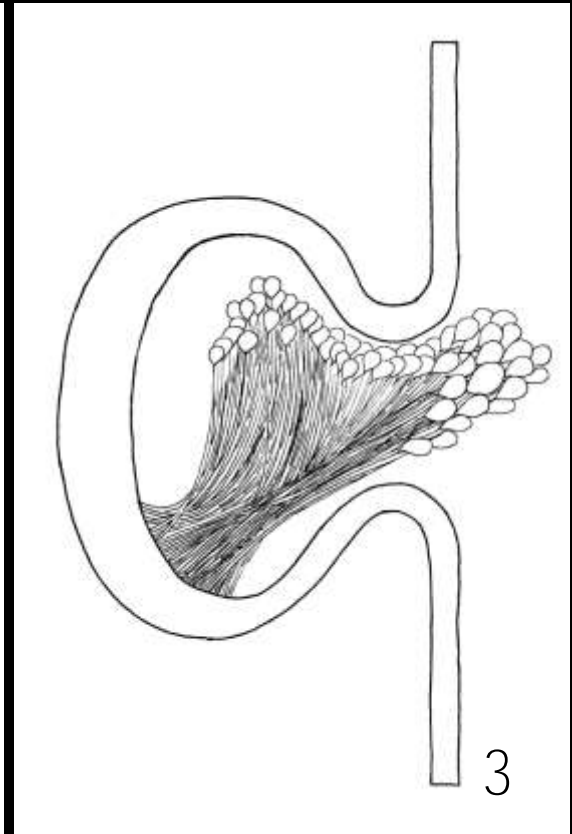
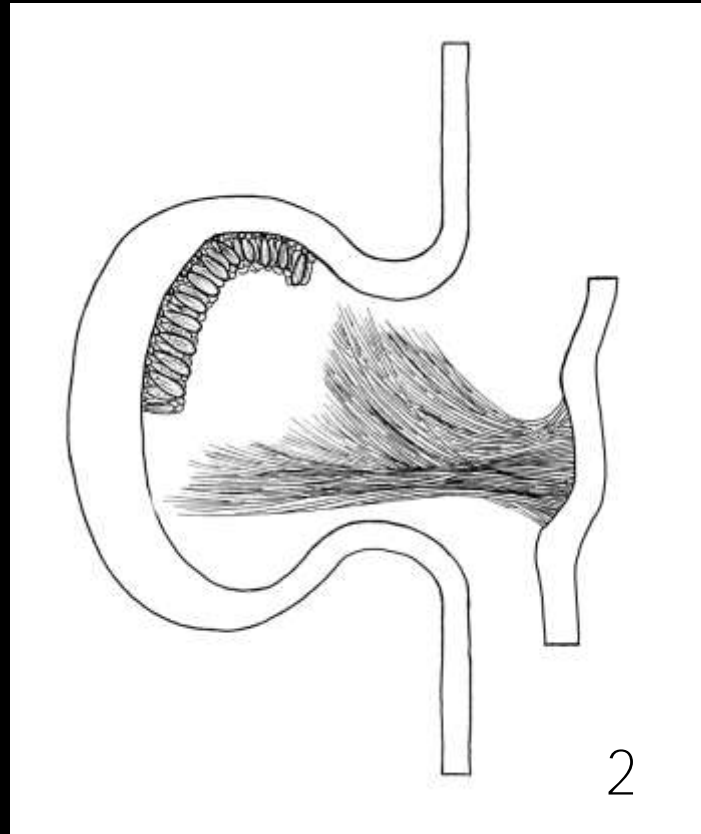
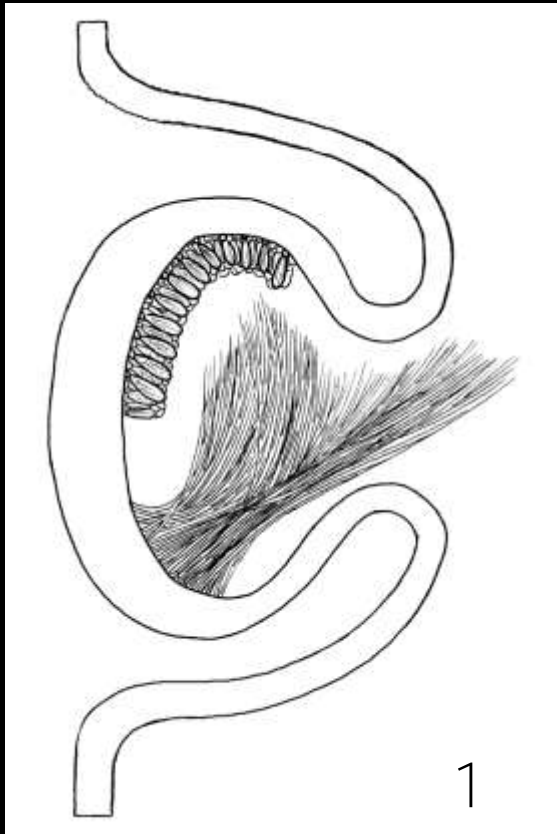
hexadecanal

trimethylpentadecan

(Nieberding, C.M et al. 2008. PLoS ONE 3(7): e2751)

Three Components of Scent Producing Systems

1. Glands for scent production
(may be associated with scale or other structure).
2. Structures for scent dissemination
3. Protective pockets



1. Protective pocket enclosing glandular scales and disseminator scales.
2. Protective pocket with glandular scales; disseminator scales separate.
3. Protective pocket with scales having both scent producing and disseminating functions.

Terminology

1. Coremata - eversible tube-like organs in abdomen with associated glands for scent production.



Tumbir_darren

Terminology

Androconia - Scales with glandular cells at their bases for scent production
(Hallberg and Poppy in Kristensen, 2003).



Bicyclus

G. San Martin



Pieris bassicae

Power & Syred

Terminology

Hairpencils - hair-like scales involved in dissemination (some are scent producing).



Terminology

1. Descriptive vs. functional terminology -scent producing scales, disseminating scales, and protective pockets.

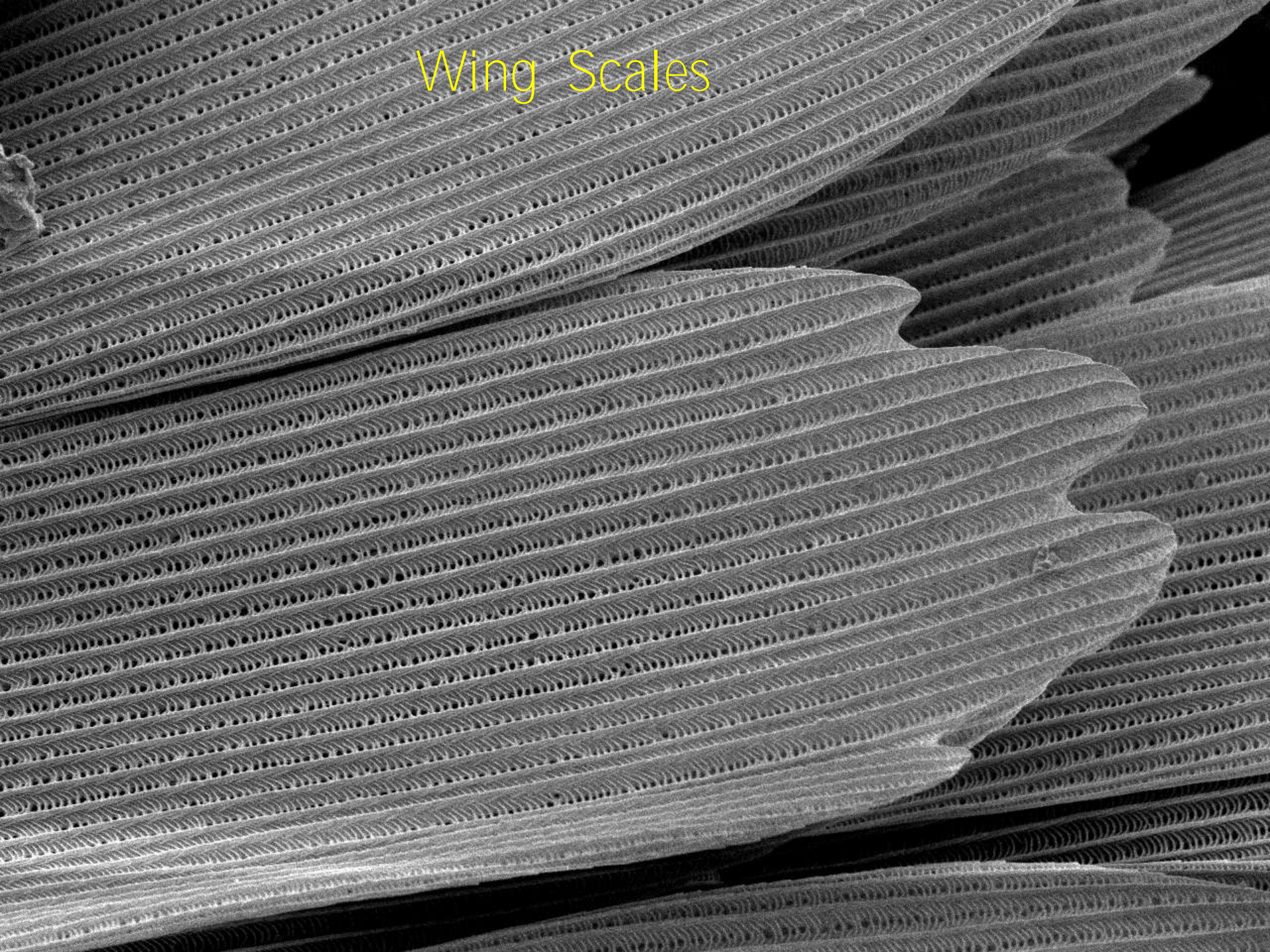
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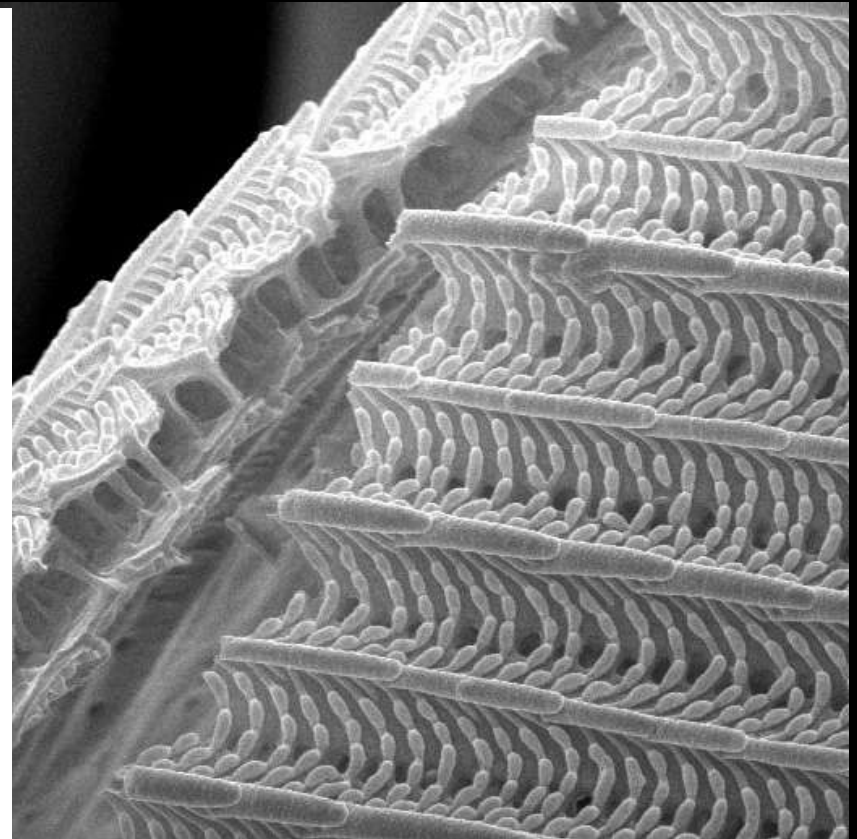
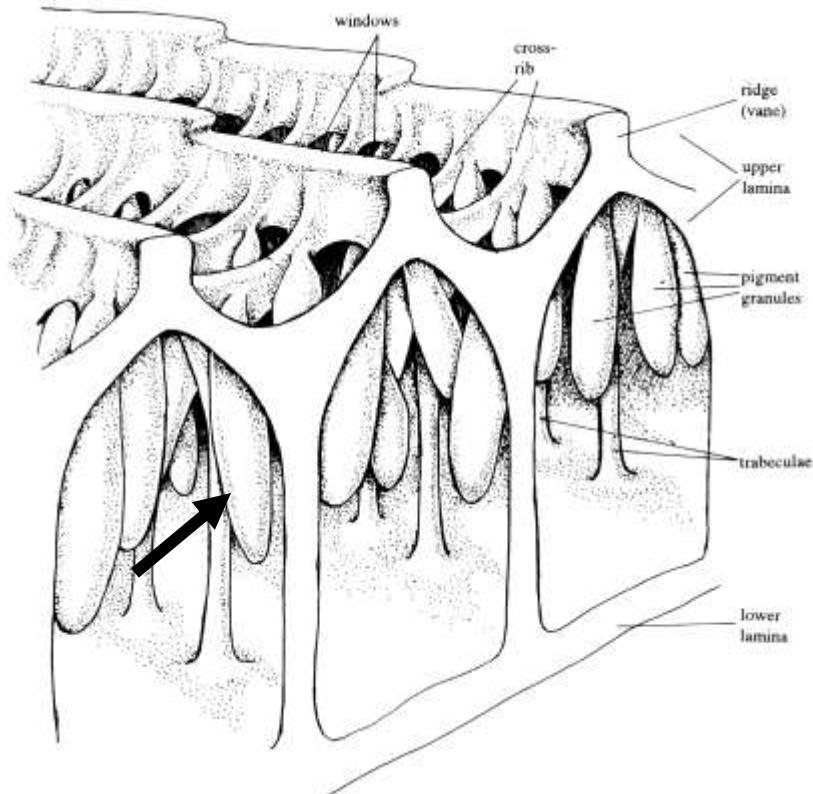
Terminology

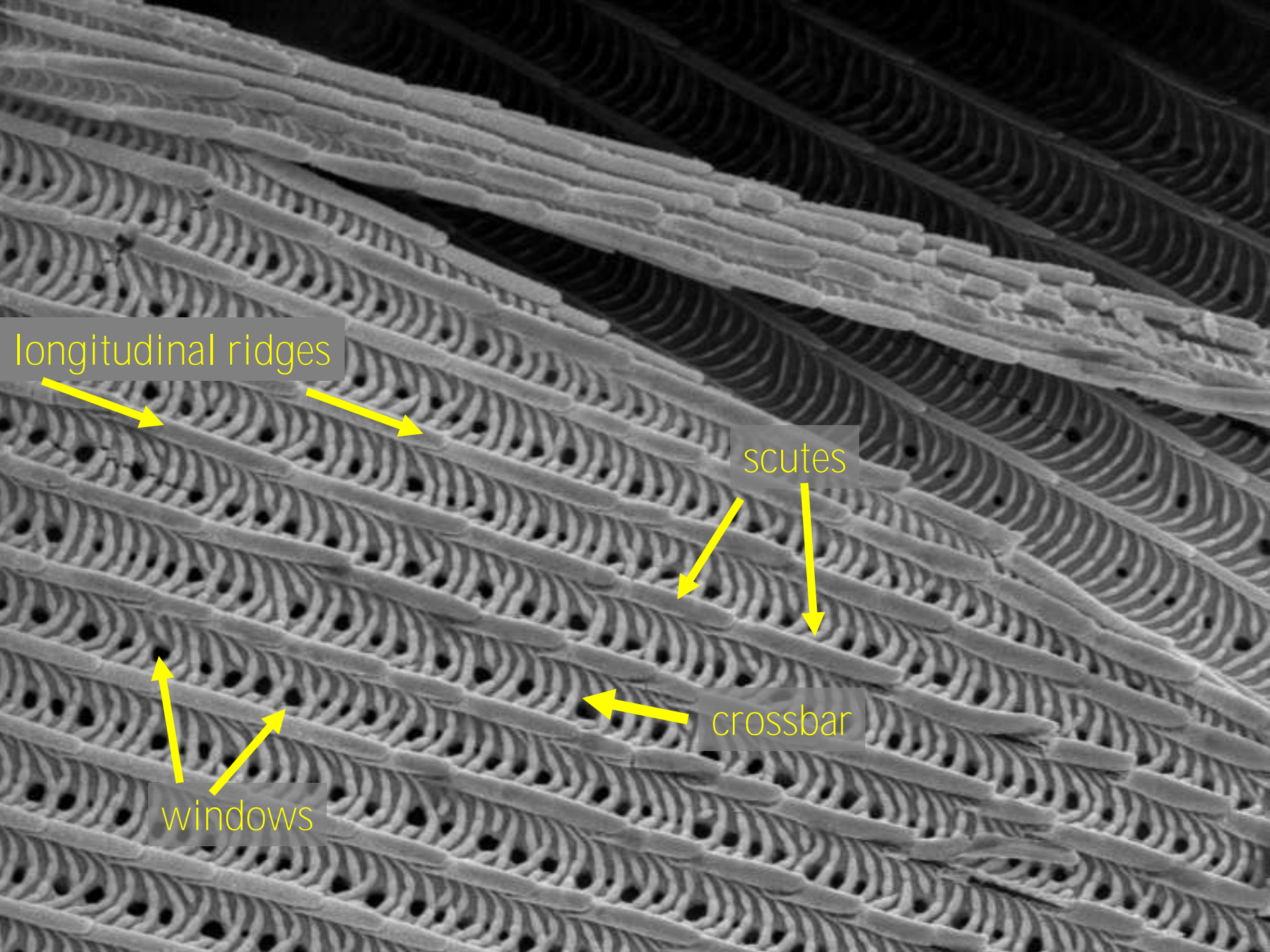
1. Descriptive vs. functional terminology -scent producing scales, disseminating scales, and protective pockets.
2. Specialized scales and structures may be present but with loss of function , e.g., presence of costal fold without an enclosed hair pencil.
3. **“Sex scale”** - a generalized term for specialized scales present only in males, without implying functionality.

Wing Scales



Hollow Scales



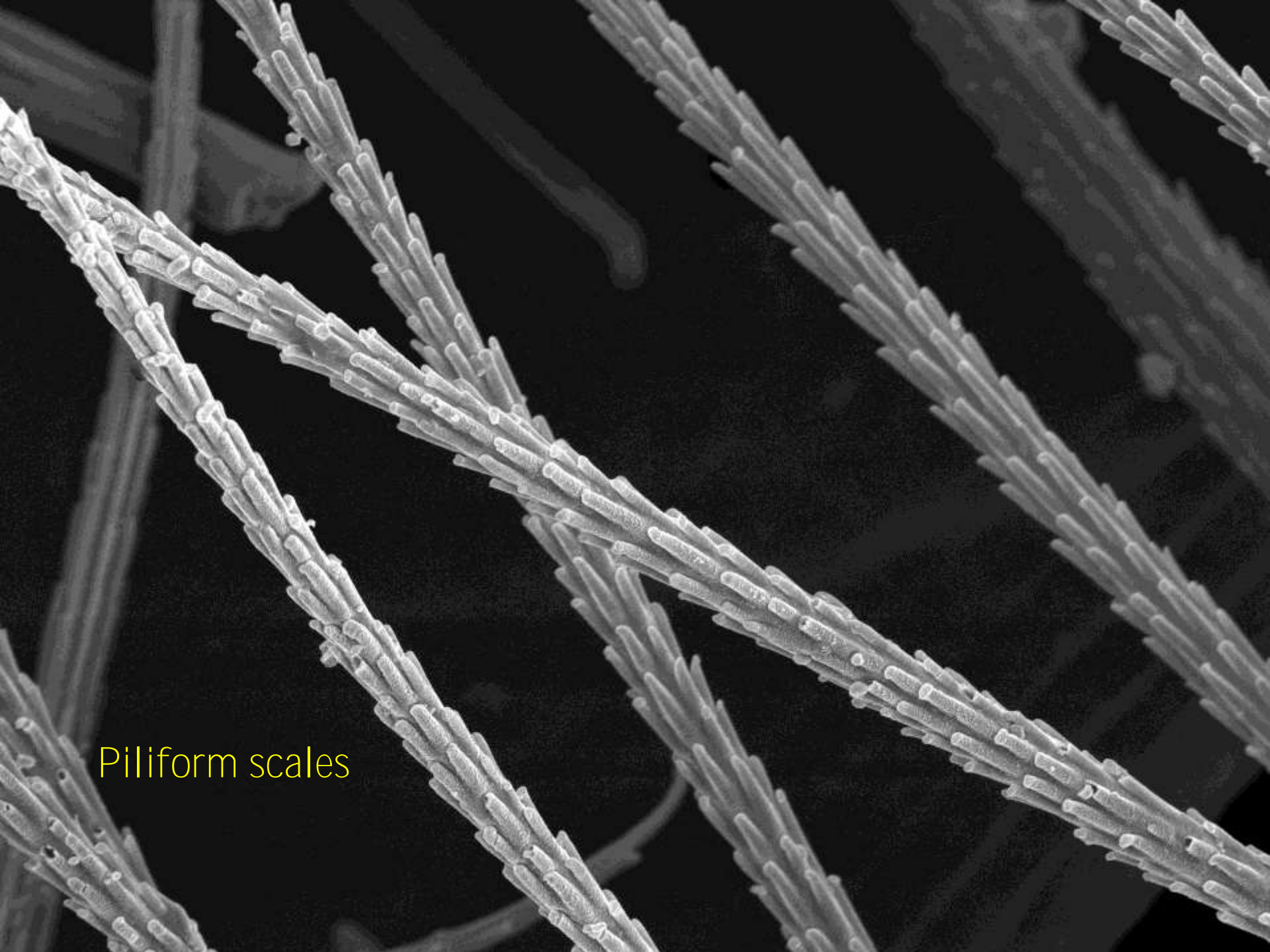


longitudinal ridges

scutes

crossbar

windows



Piliform scales

Diversity of Sex Scales in Lepidoptera



Taxa with High Diversity of Sex Scales

Gelechiidae

Tortricidae

Pyralidae

Papilionoidea

Notodontidae

Erebidae

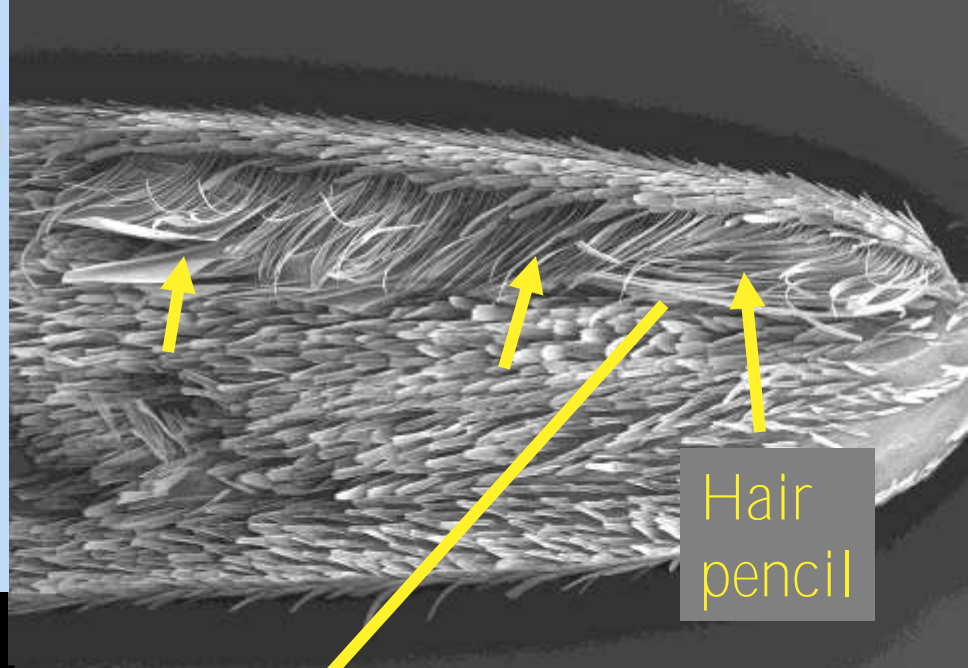
Noctuidae

Gelechiidae

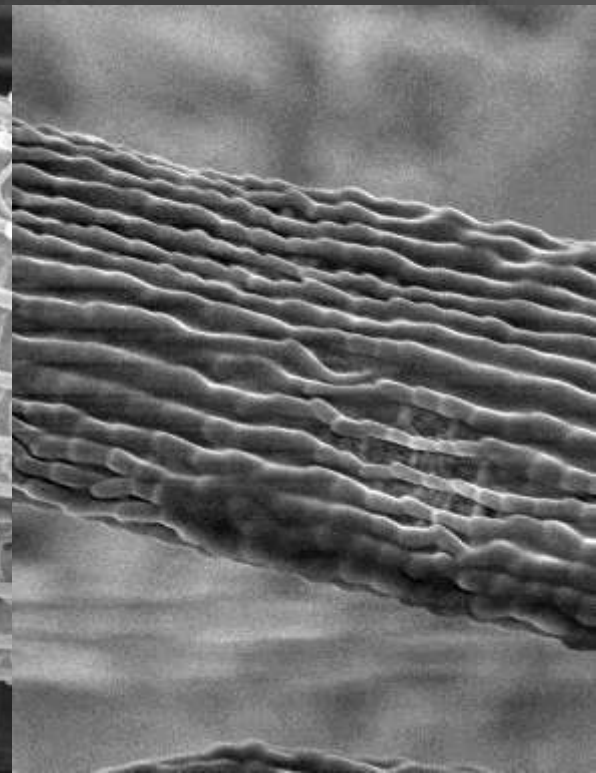
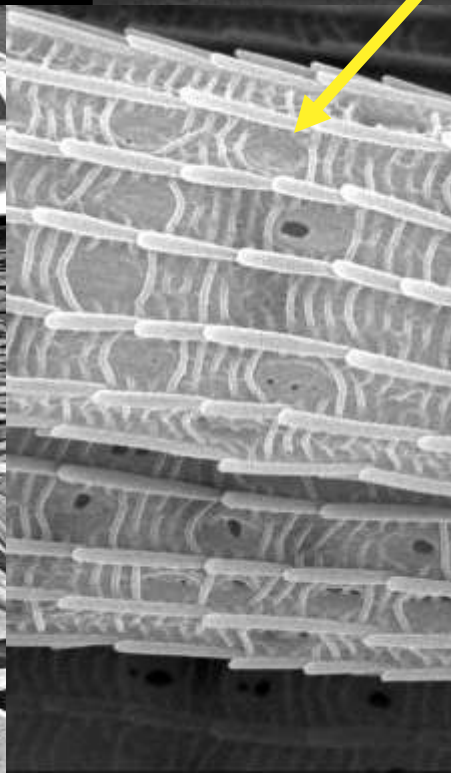
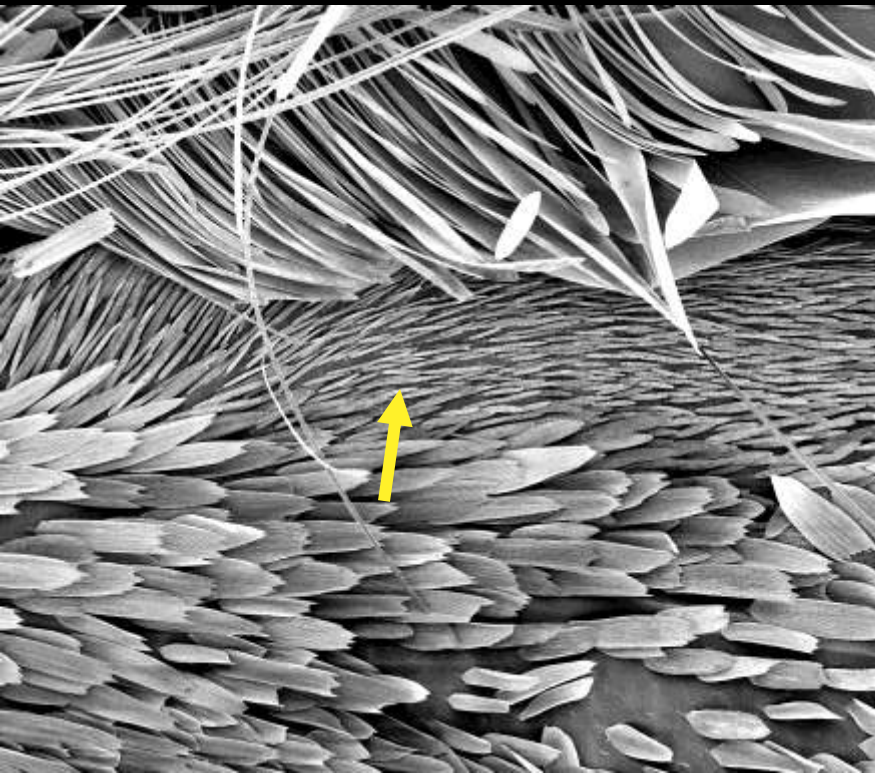




Stegasta bosqueella

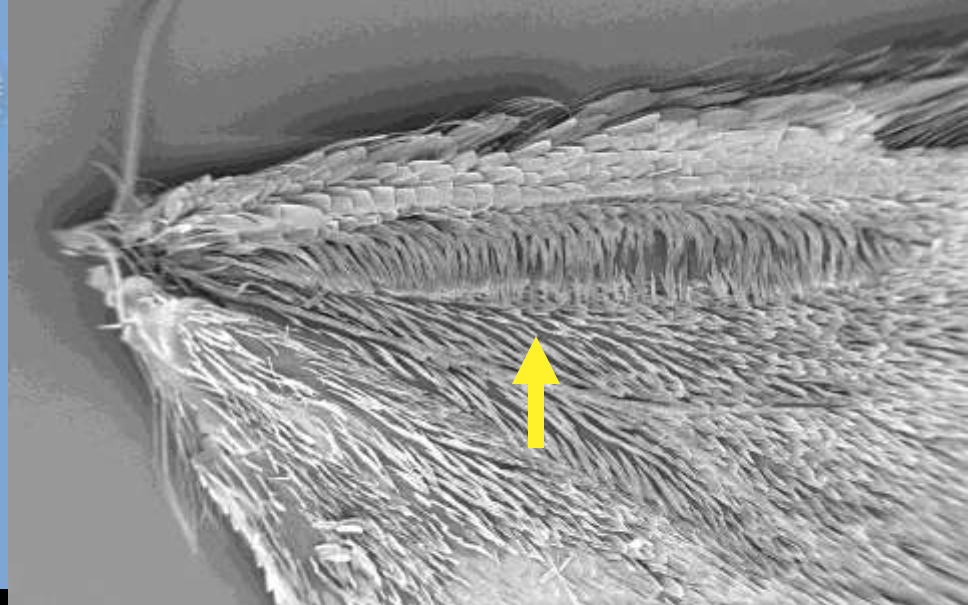


Hair
pencil

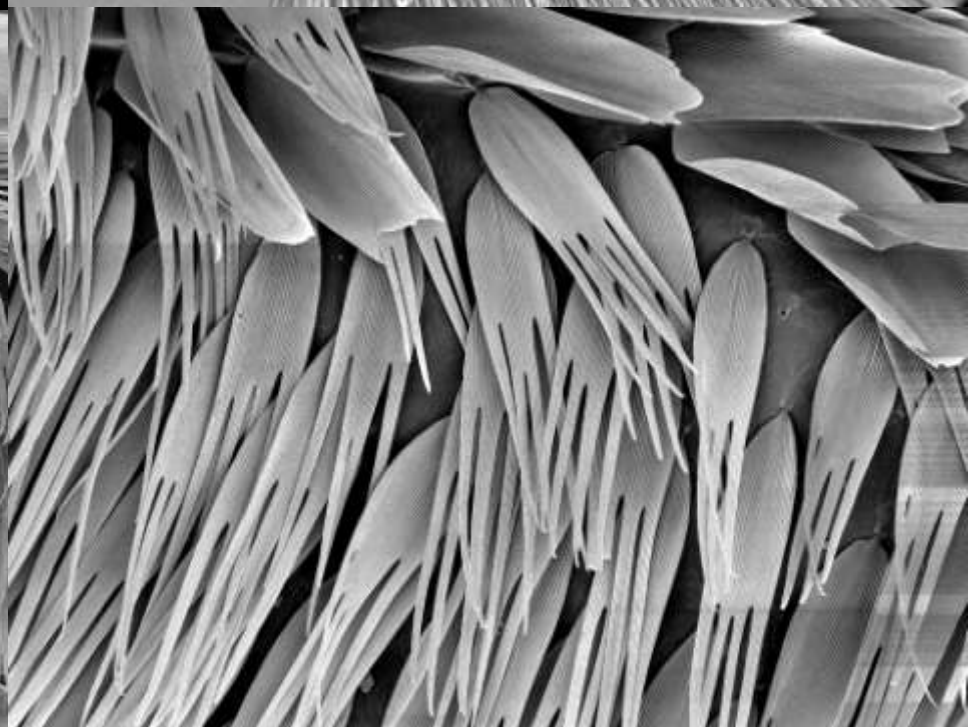
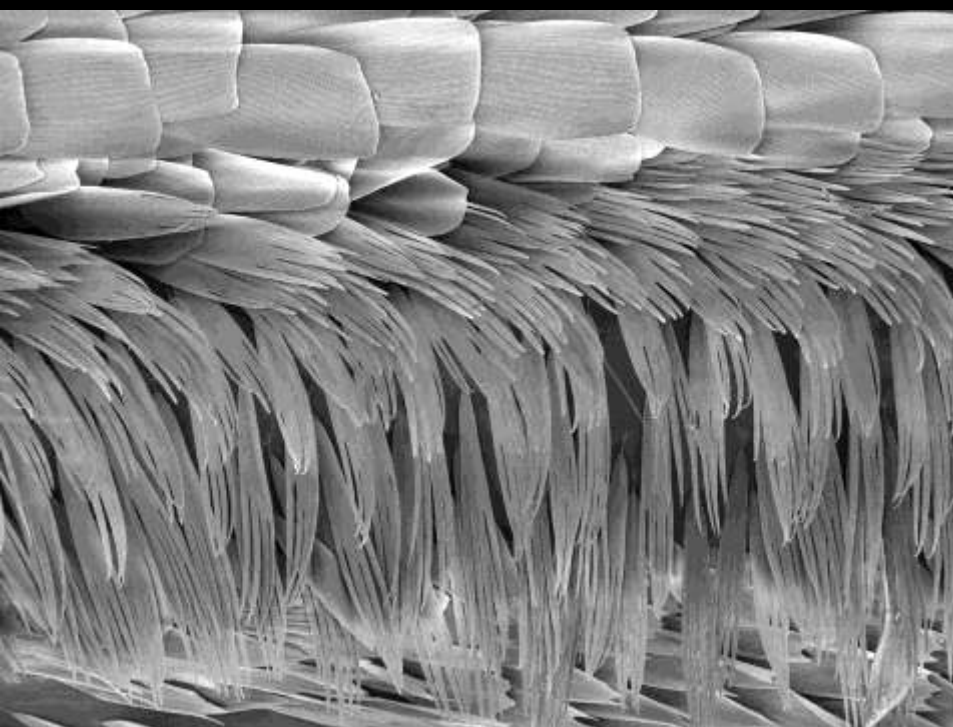




Filatima serotinella

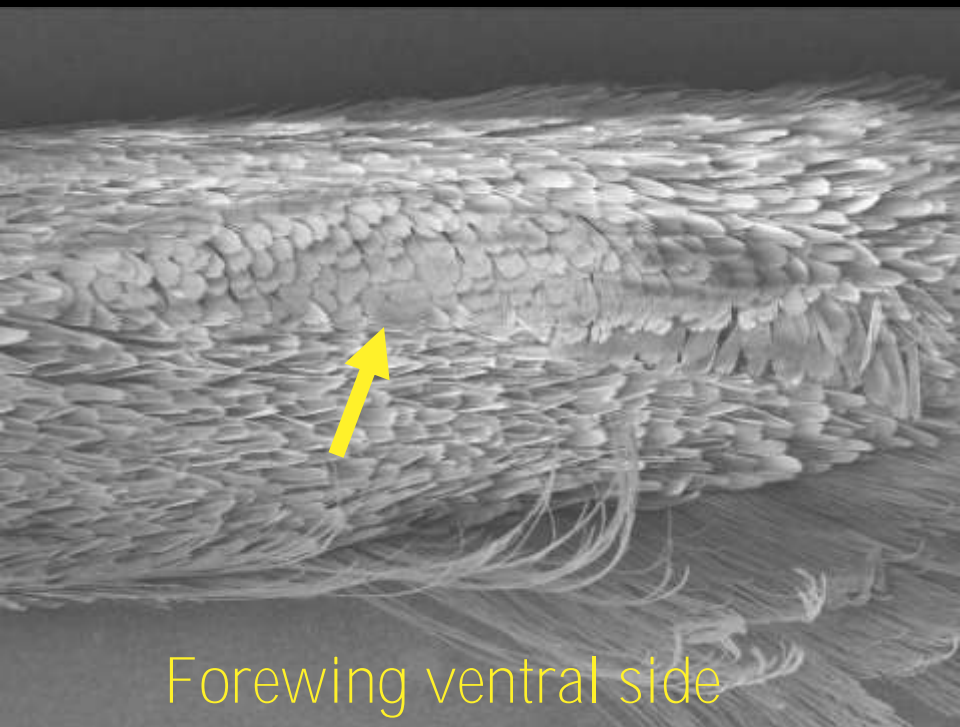


Hindwing curtain scales





Exotelia pinifoliella



Forewing ventral side





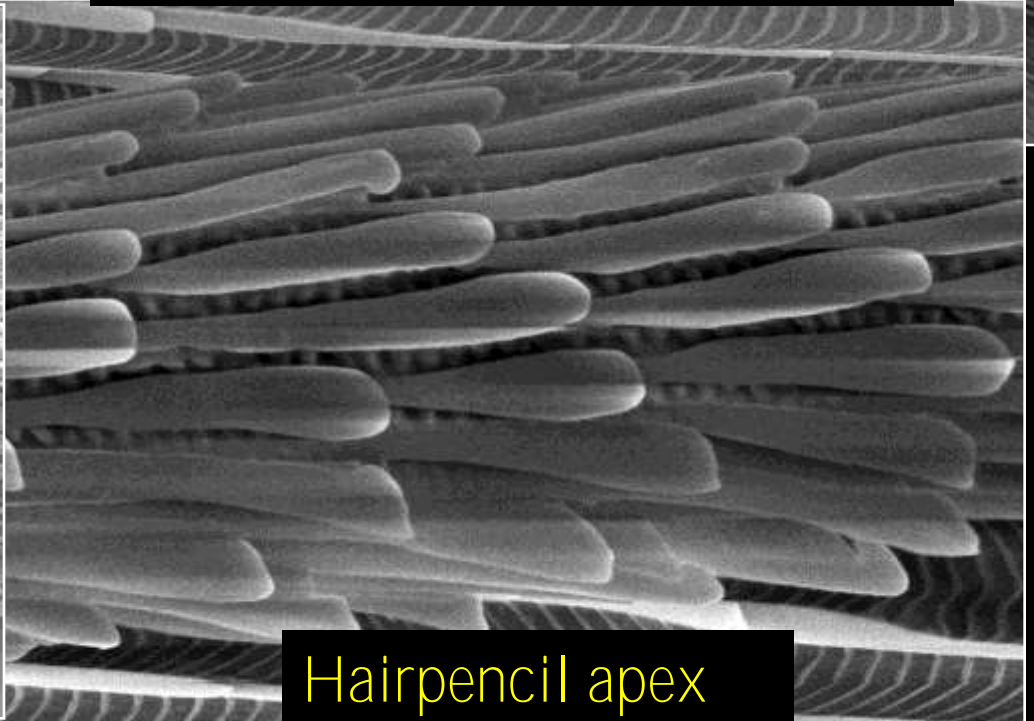
Aroga compositella



Hindwing costa - dorsal side



Forewing ventral side

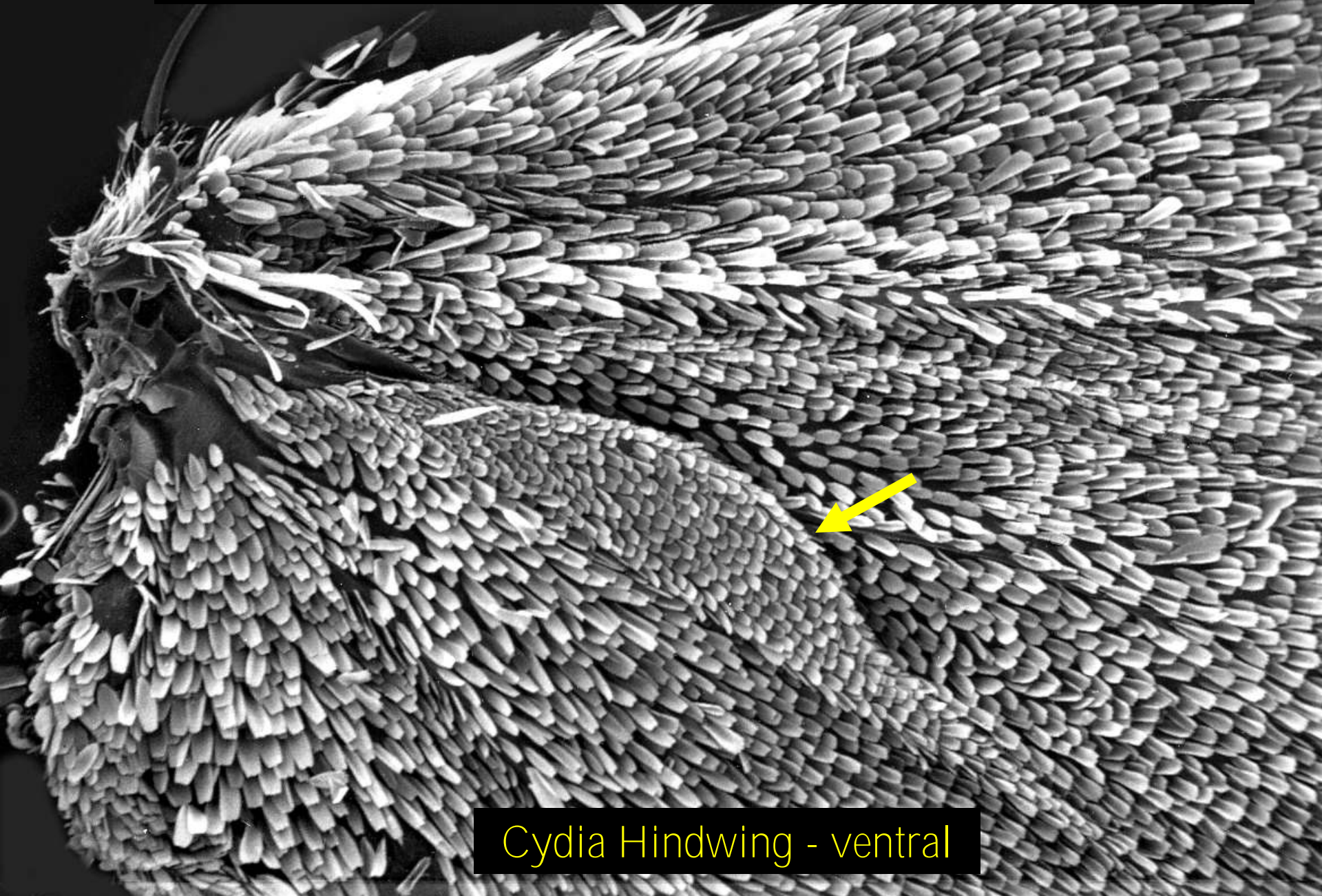


Hairpencil apex

Tortricidae



Glandular and Disseminator Scales in Same Pocket - I

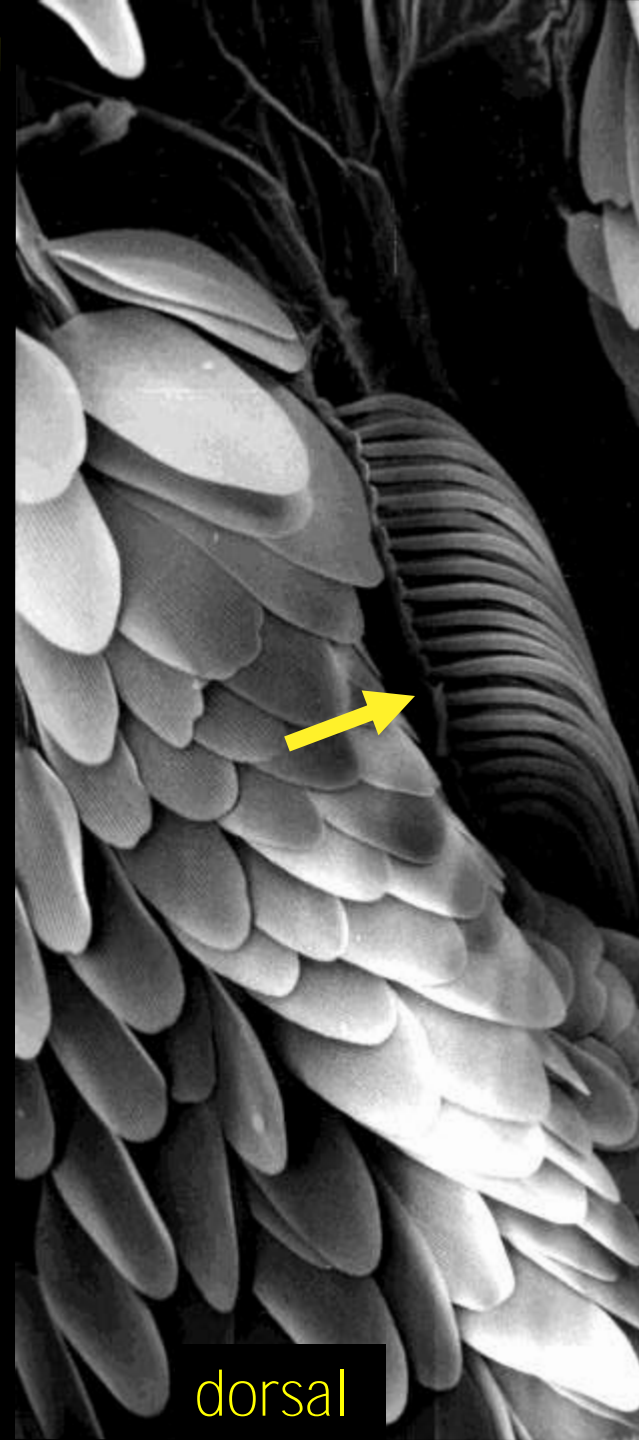


Cydia Hindwing - ventral

Cydia Hindwi

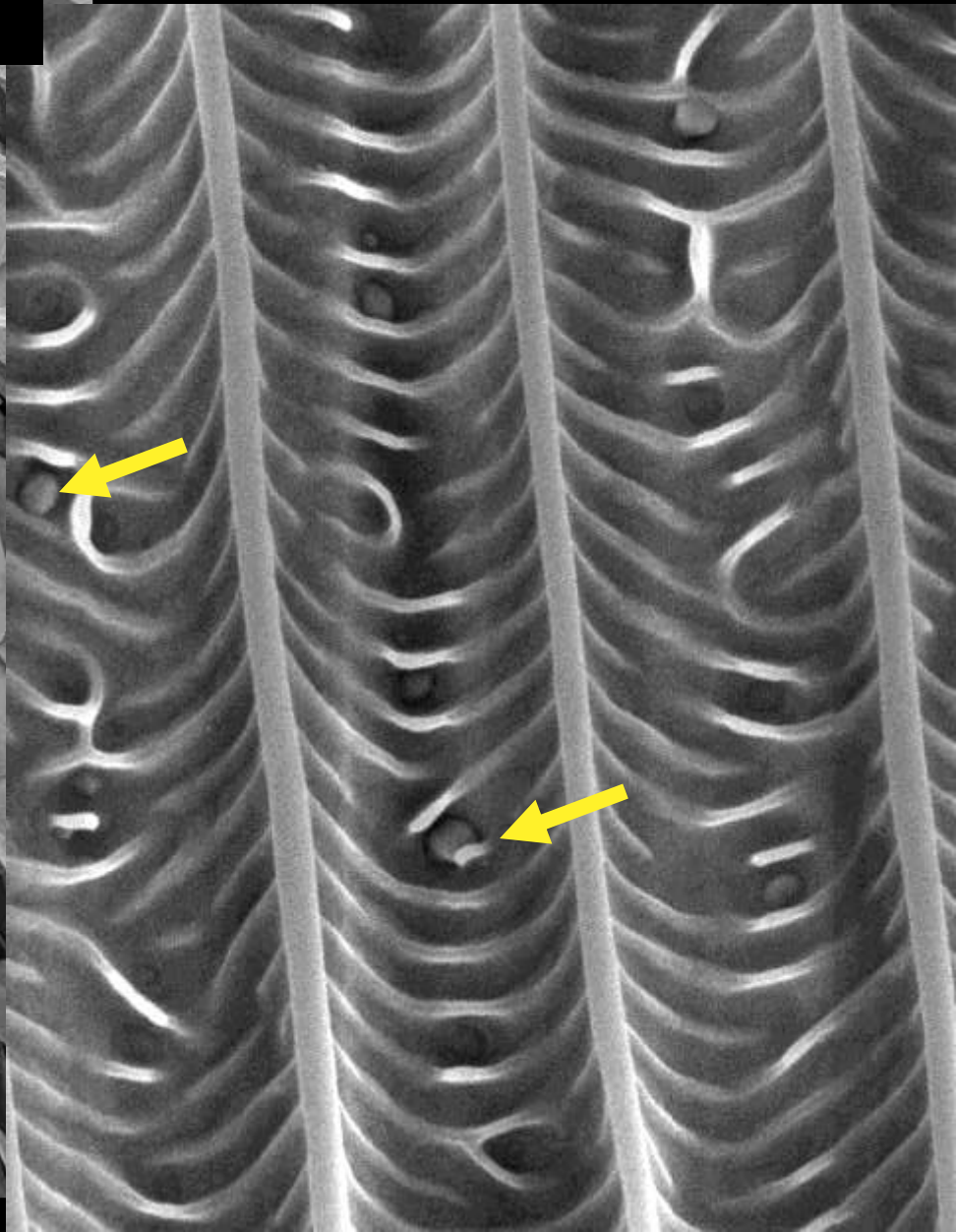
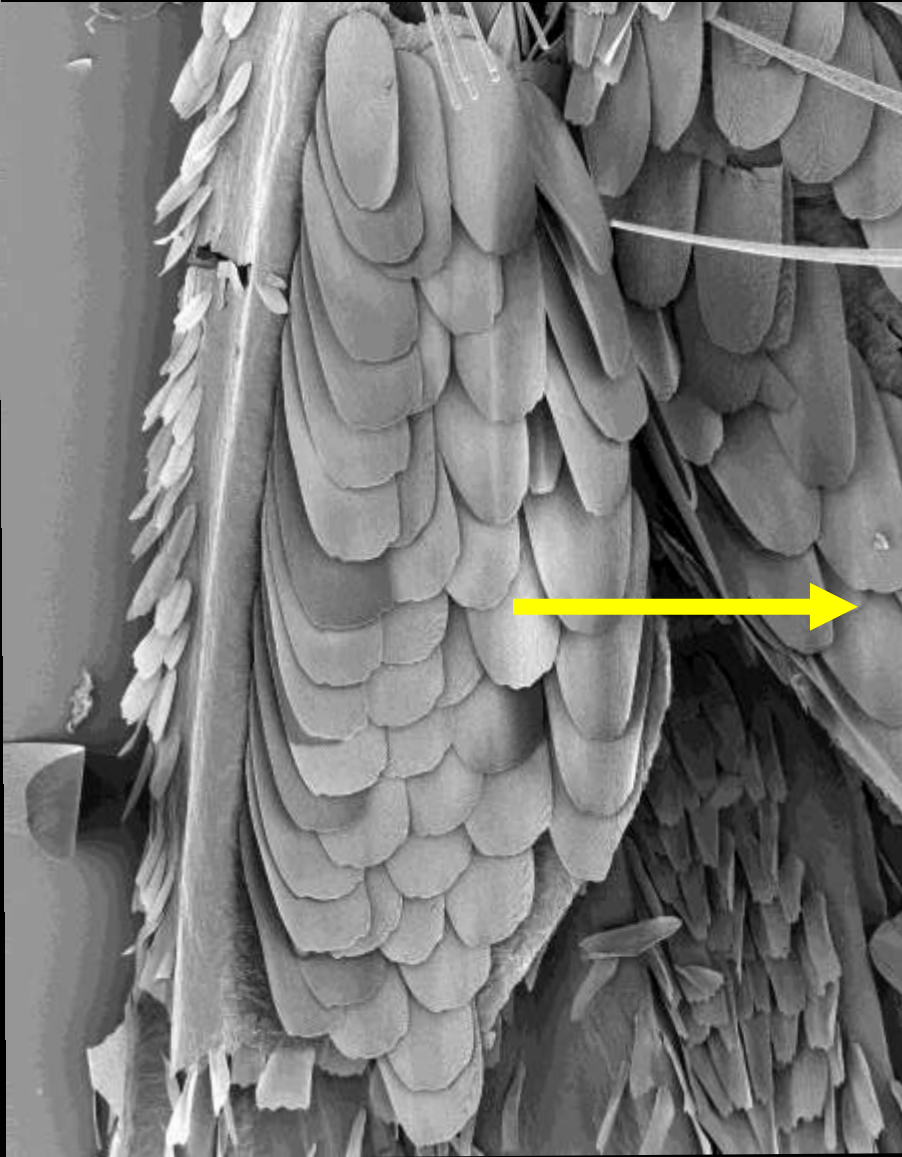


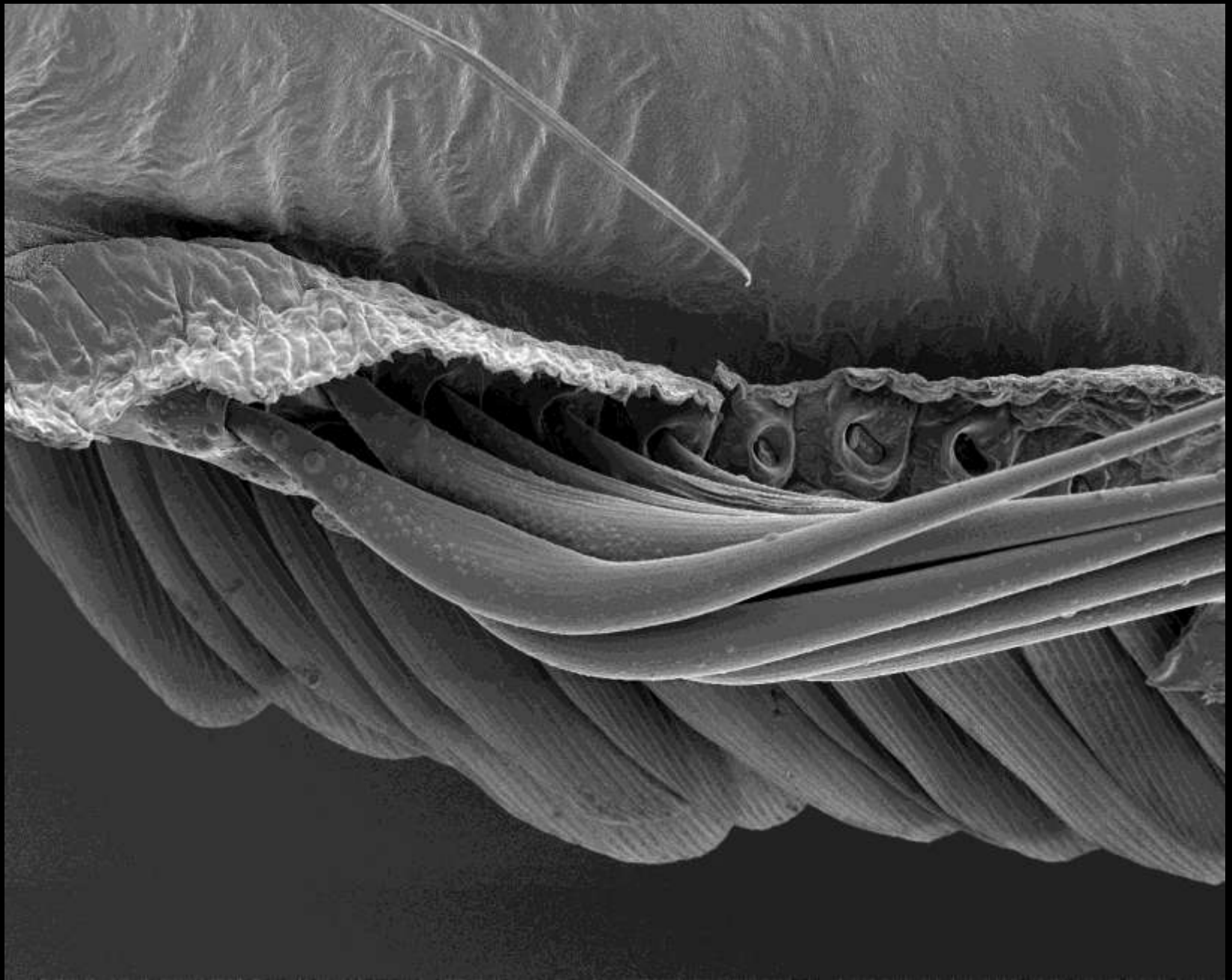
ventral

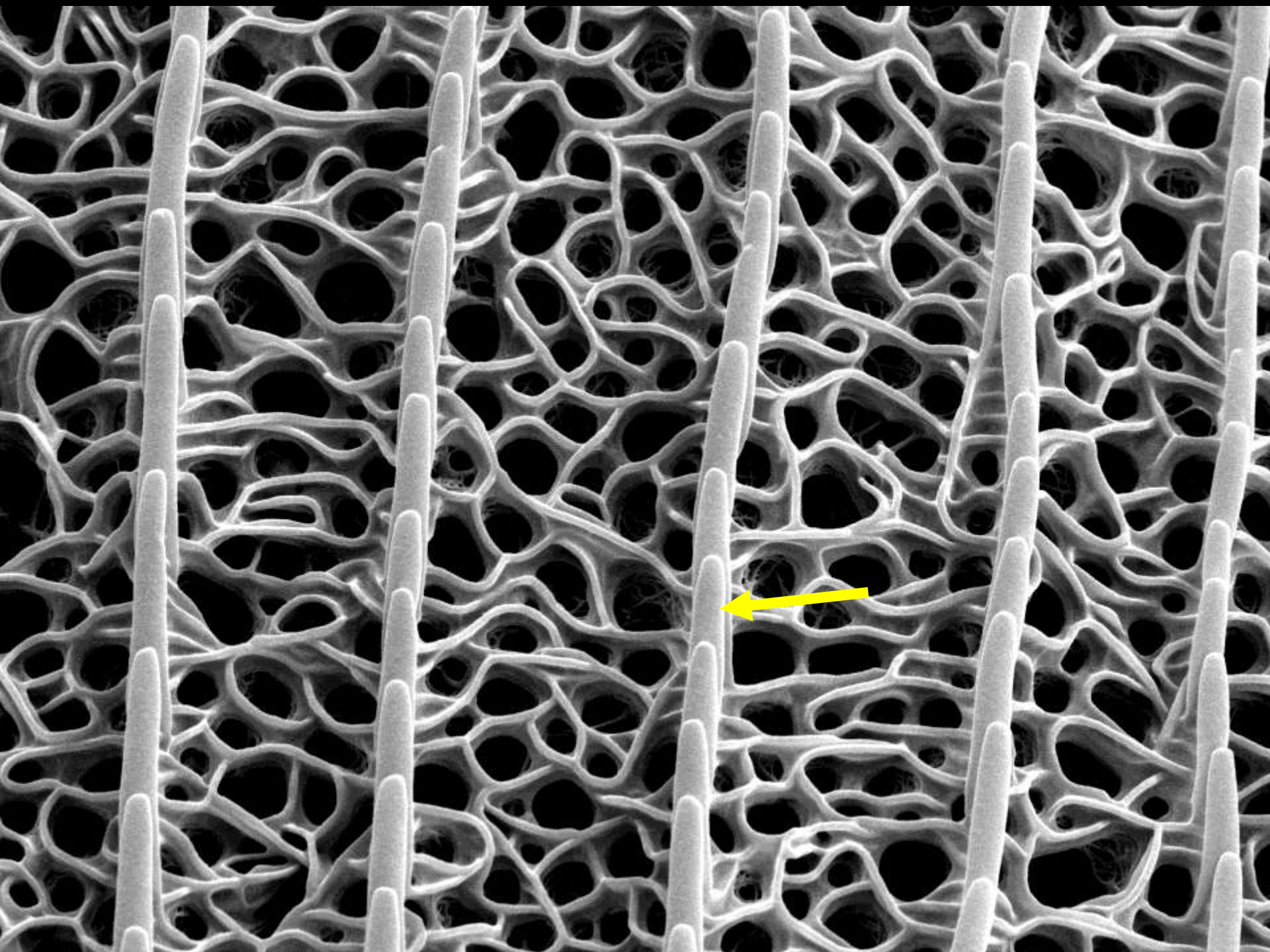


dorsal

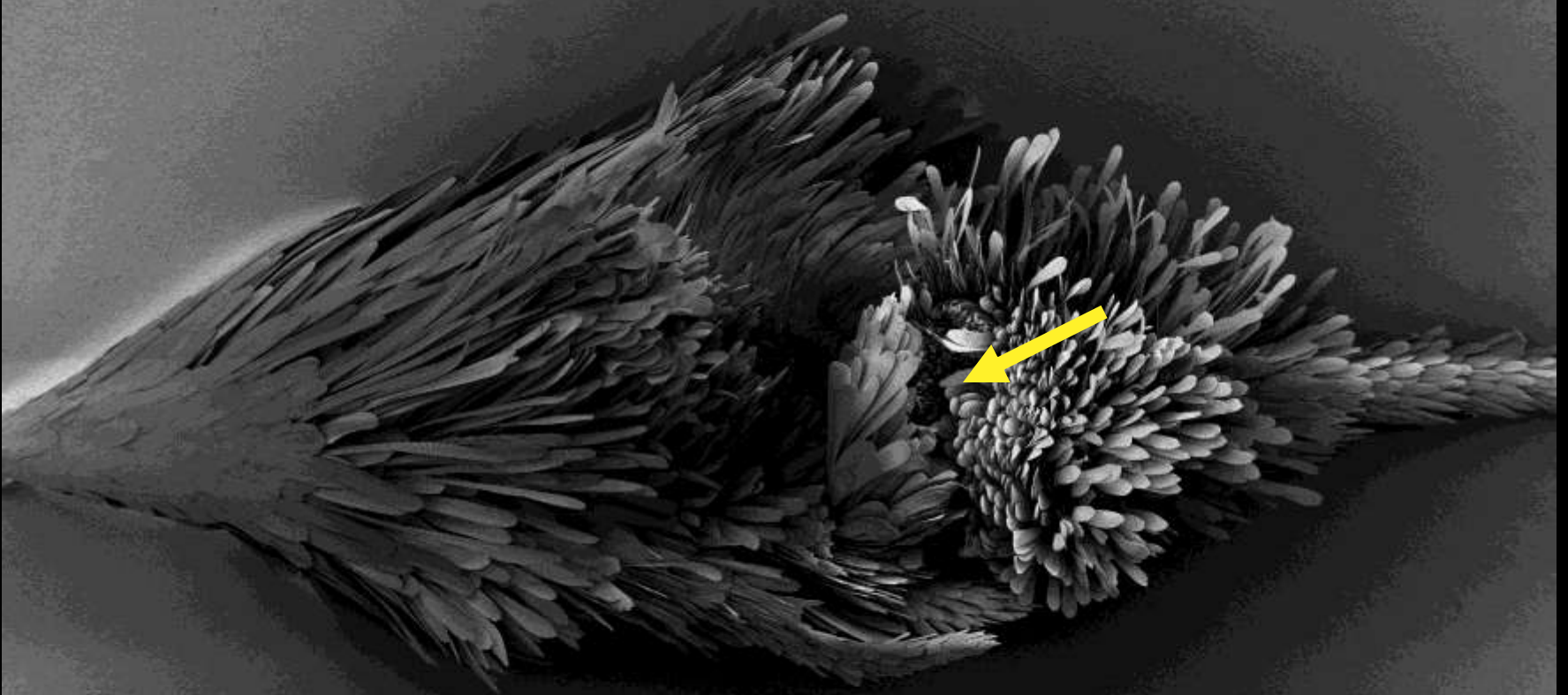
Cydia Hindwing Pocket Opened



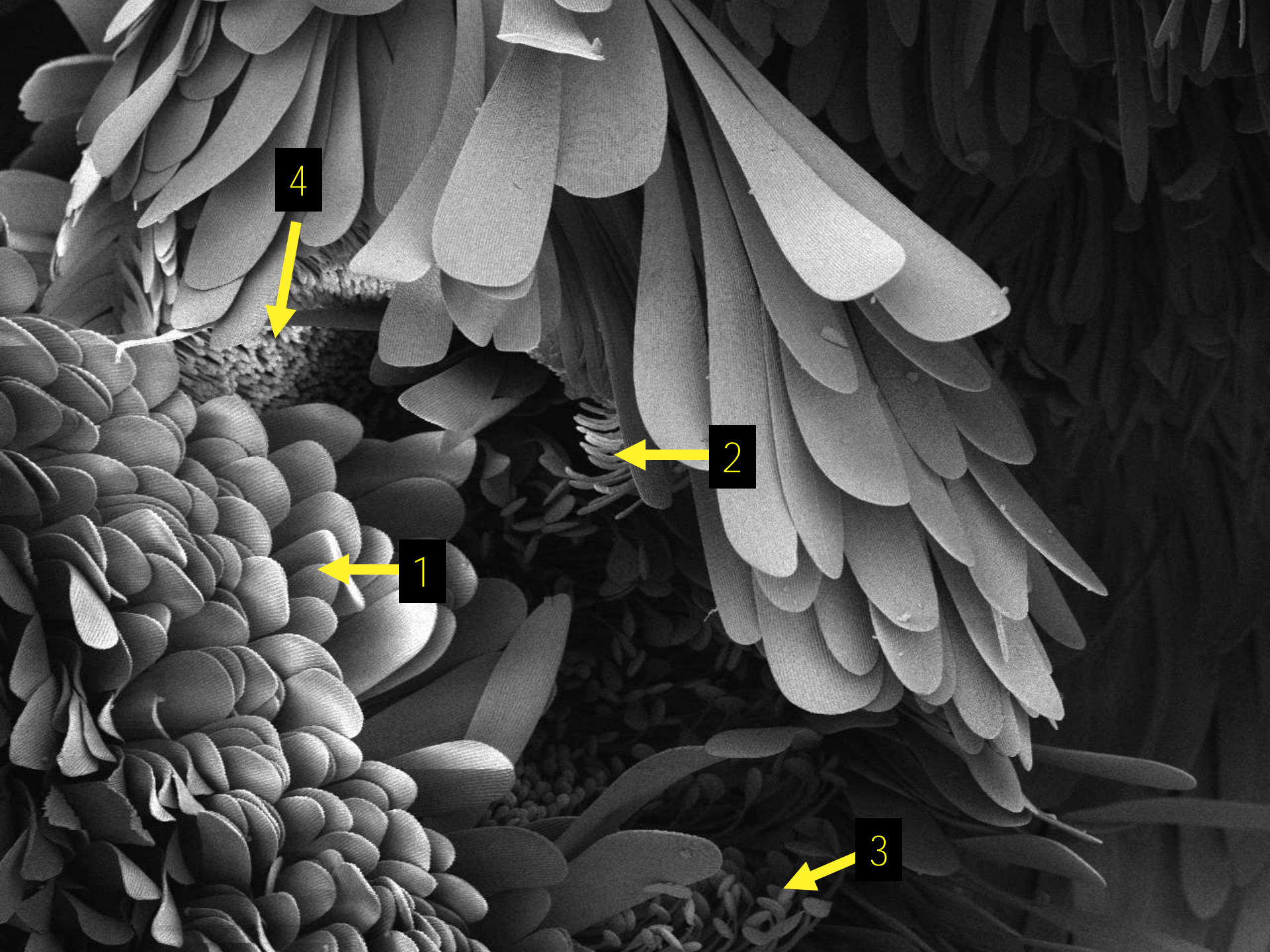




Glandular and Disseminator Scales in Same Pocket - II



Hindleg of *Thaumatotibia leucotreta*

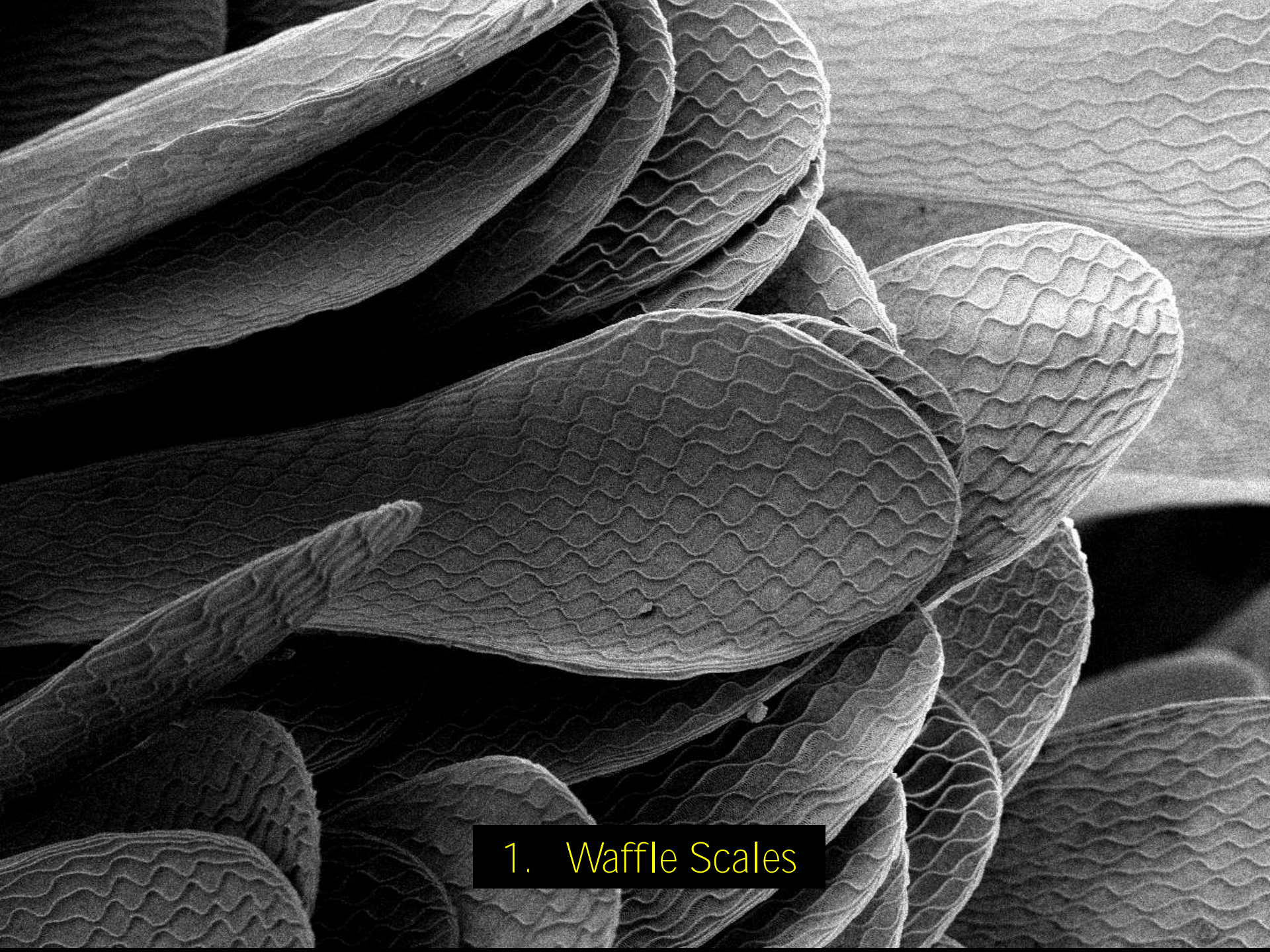


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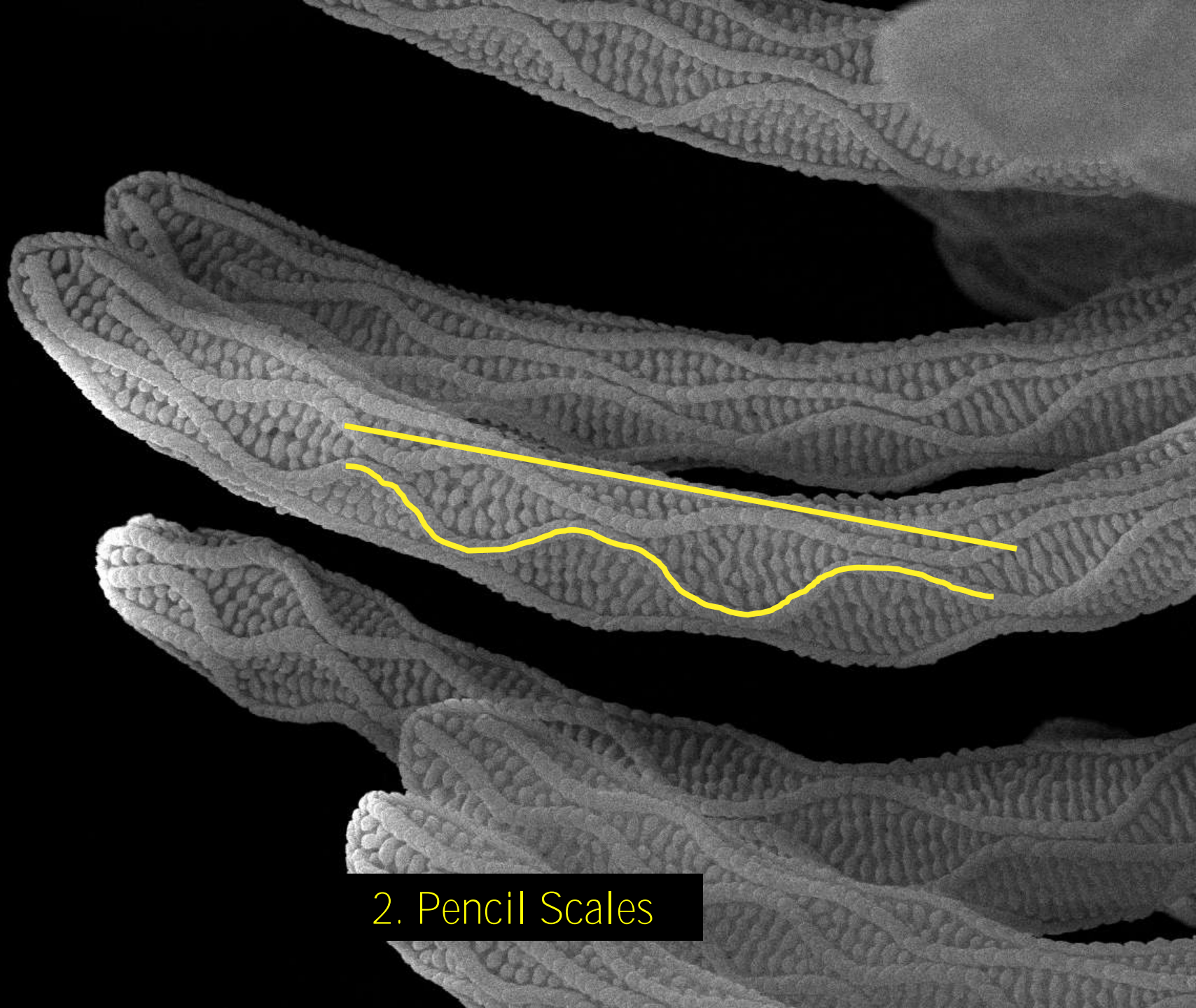
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1

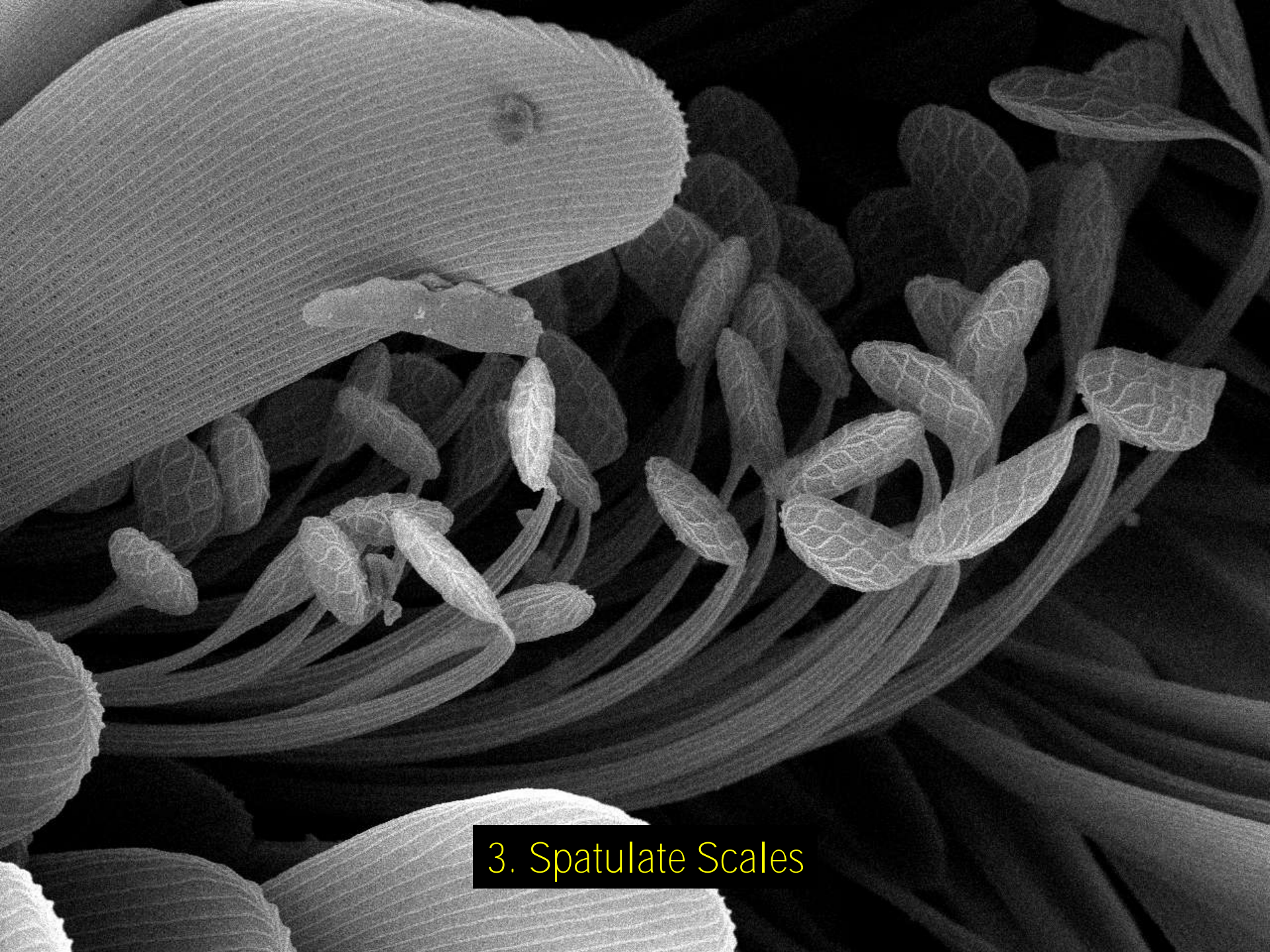
3



1. Waffle Scales

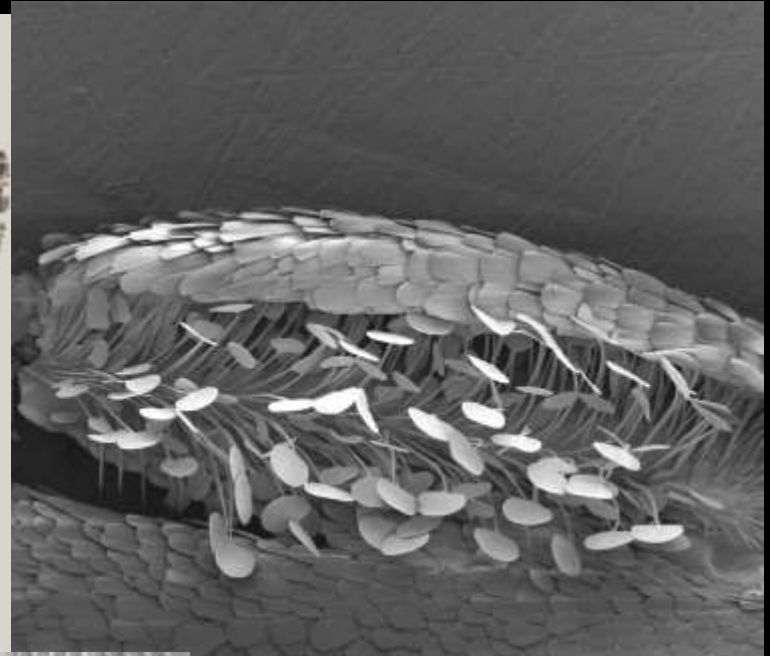


2. Pencil Scales

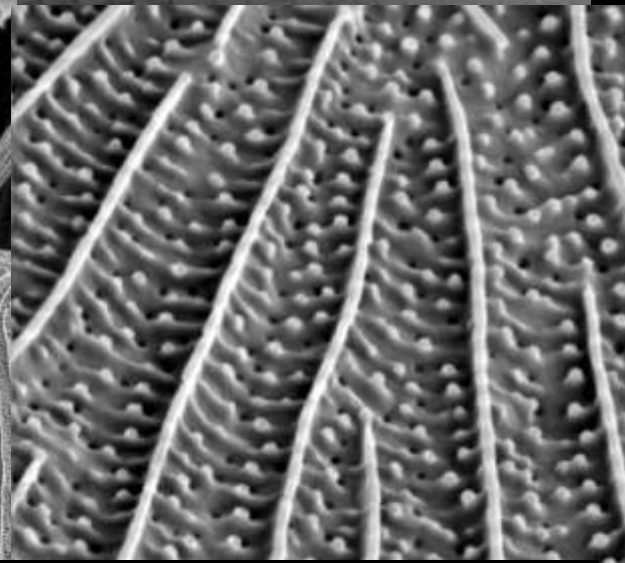
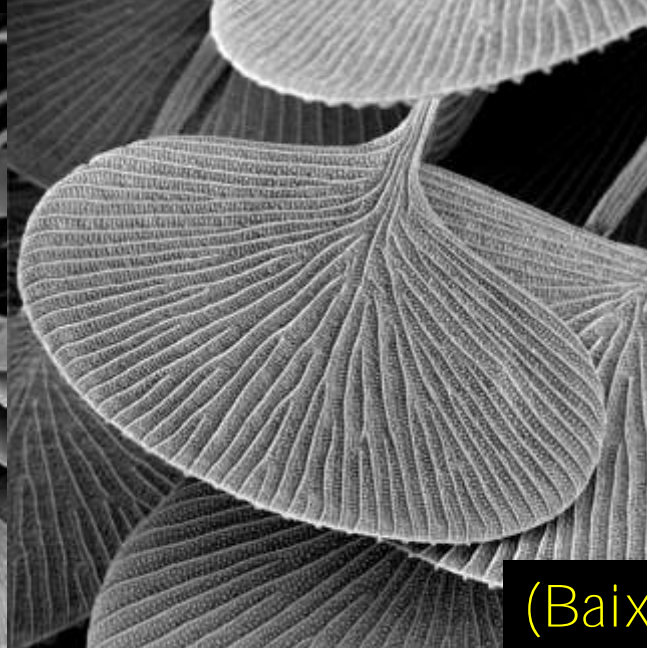
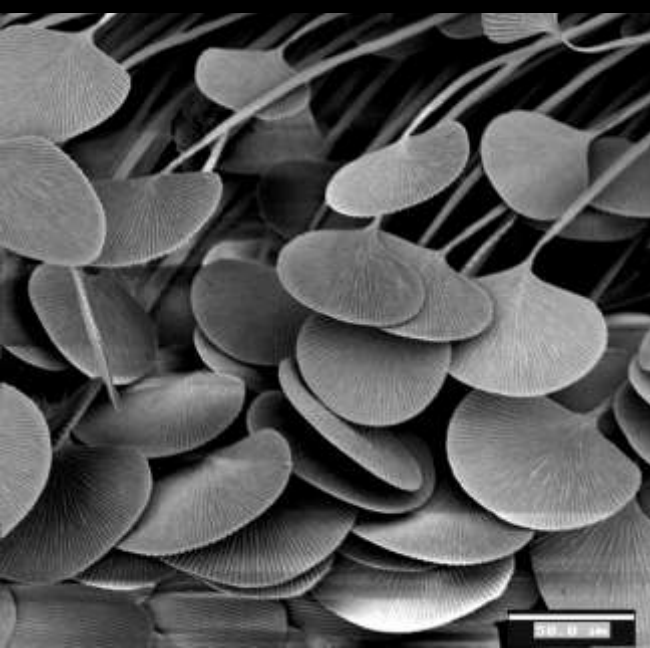


3. Spatulate Scales

Pocket with Scales Having Both Glandular and Dissemation Functions

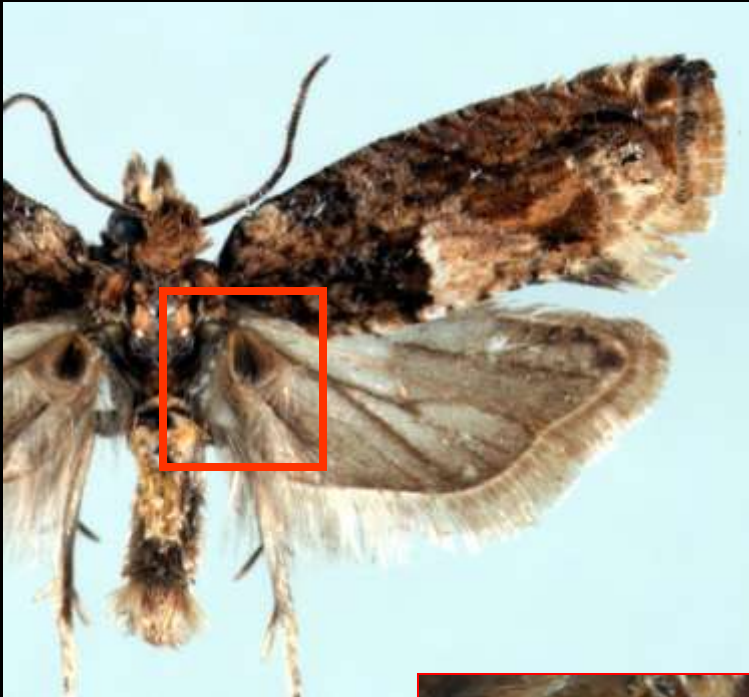


Crociosema lantana



(Baixeras & Brown, in prep.)

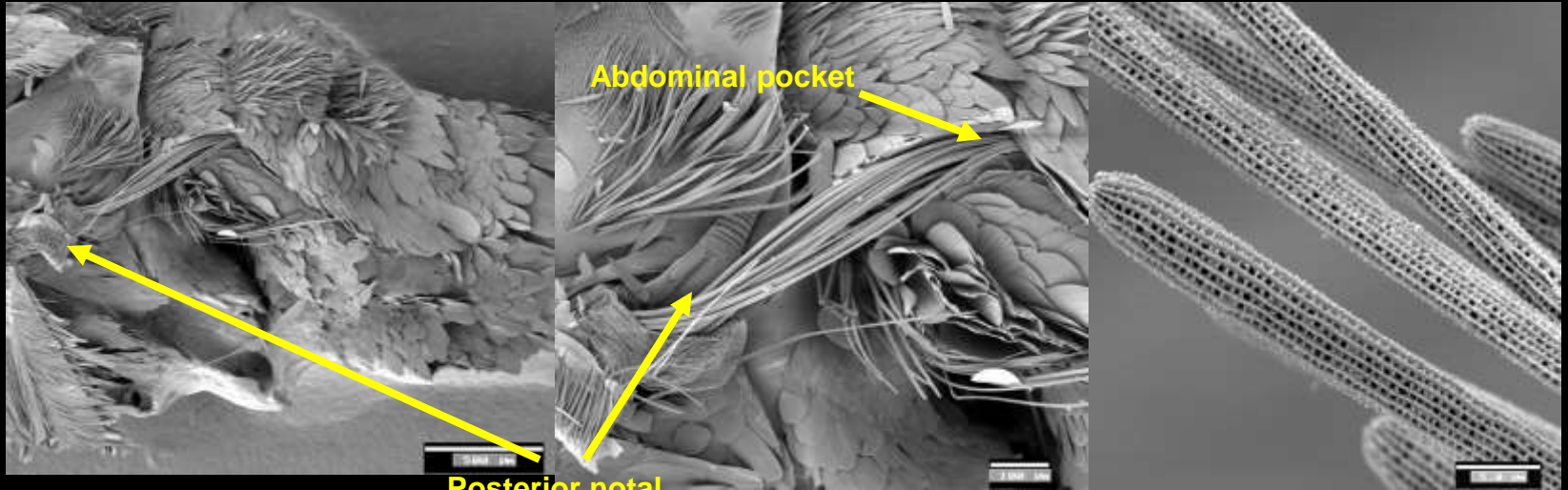
Glandular and Dissemination Scales on Different Body Parts -I



Crocidosema plebejana

(Baixeras & Brown, in prep.)

Glandular and Dissemination Scales on Different Body Parts -II



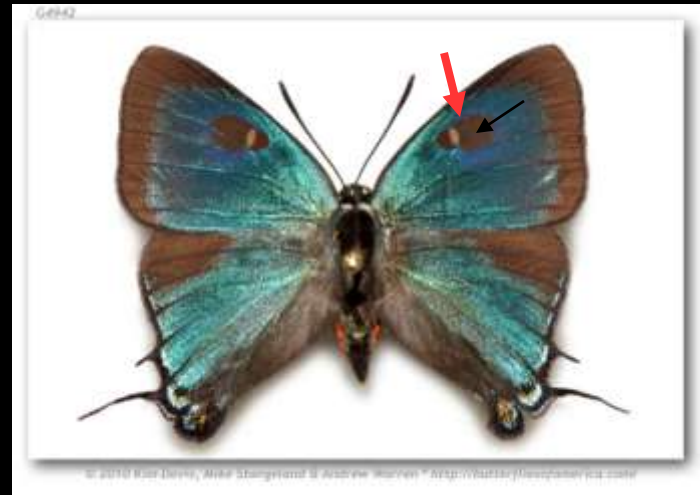
Criocidosema lantana group



Papilionoidea



Carcharodus (Hesperiidae) P. Bruce-Jones



Atlides halesus (Lycaenidae)

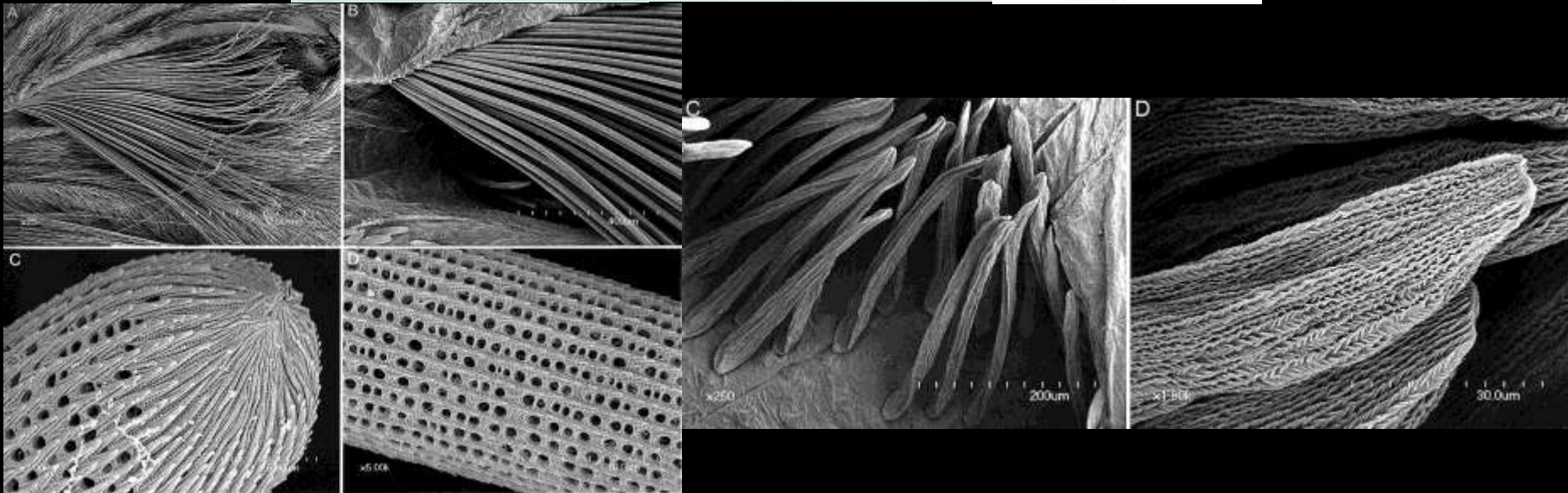
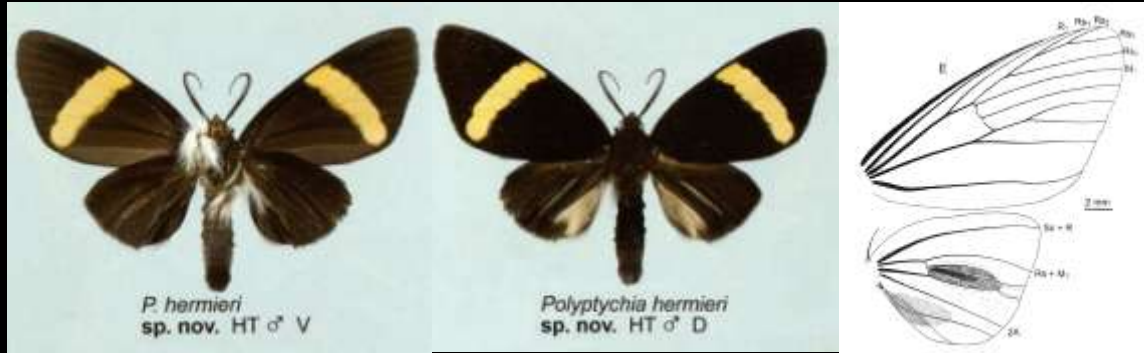


Nymphalidae Hans-Peter. Creative Commons

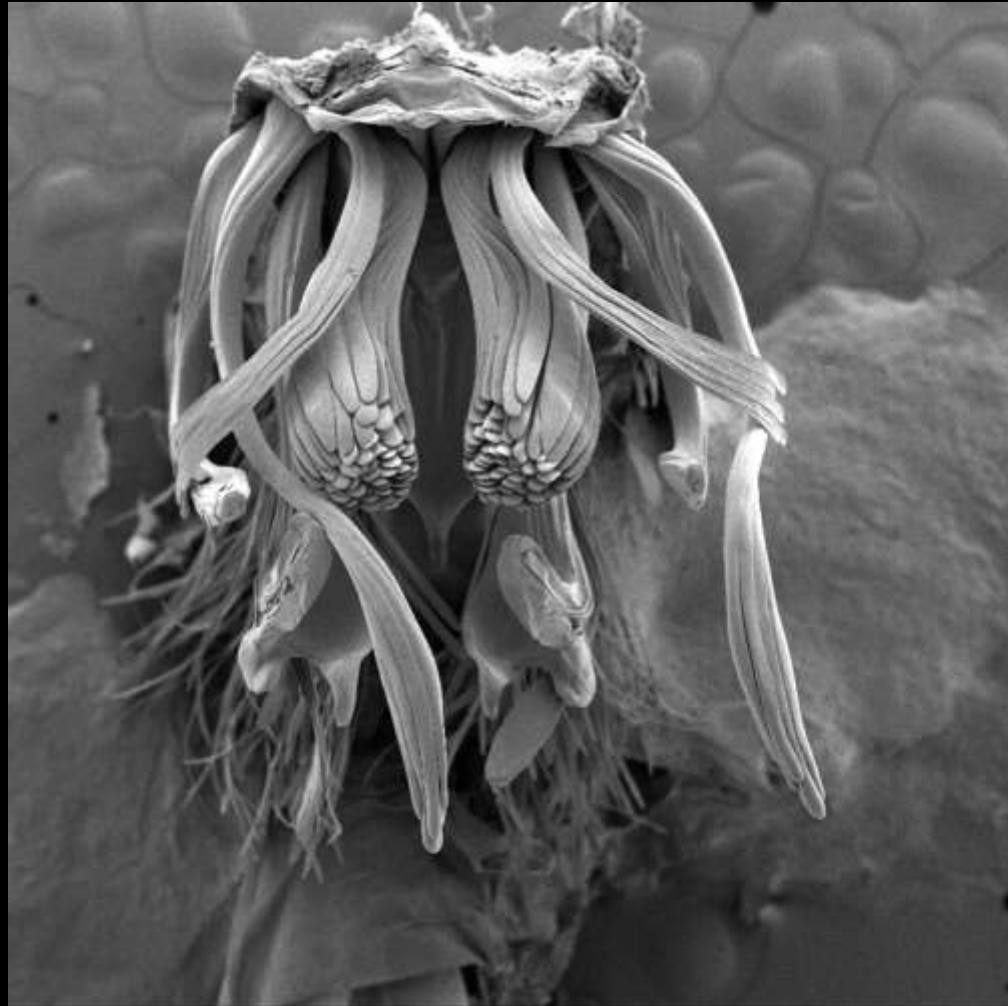


Pieridae

Notodontidae (Dioptinae)



Pyralidae



Amanda Roe

Dioryctria

Wicks for Dispersal of Deer Scents



DEER WICKS (tm)

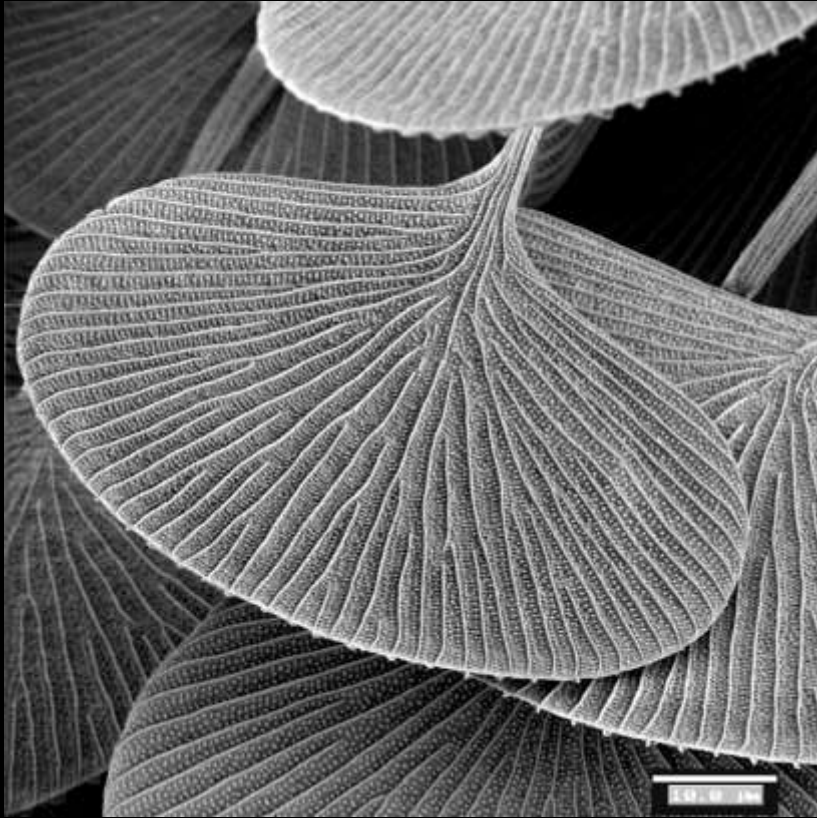
The Best Scent Delivery System

We have carefully engineered our Deer Wick to be the best scent delivery system on the market

Rain Guard: Deer Wicks have an outer plastic shell that sheds rain, preserves scent, and keeps the scent pad active.

Micro - holes: Deer Wicks have hundreds of micro-holes and a unique air-flow through design to get scent airborne easily.

Natural and Commercial Wicks



Acknowledgements

We thank **William Munroe and Richard Kuklinski, MSU Electron Microscope Center**, for their assistance with microscopy.

Photographs of living specimens of Gelechiidae and Tortricidae were obtained from the Moth Photographers Group website.

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